Deherainia smaragdina, Dcne.

BY

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With Plate LIX.

DEHERAINIA SMARAGDINA was described in 1876 by Decaisne,* and the genus was named by him in honour of M. Pierre-Paul Deherain, aide-naturaliste of the Museum of the Jardin des Plantes. Later, in 1878, we have a description of the plant by Hooker † from a specimen growing at Kew. It thrives best as a stove plant, under warm, moist conditions, for the conditions of its native habitat, near Tabasco, Mexico, are damp and tropical. The particularly fine specimen—a symmetrical, well-formed shrub from 5–6 ft. in height—in the Royal Botanic Garden, Edinburgh, has afforded material for the following description :—

Deherainia smaragdina, of the order Theophrastaceae, is a much-branched, woody shrub, with twigs, leaves, and flower stalks covered with rusty-brown hairs. The leaves are simple, lanceolate, 2–5 in. in length, acute, alternate in arrangement, and crowded together at the apex of the branches in the form of a rosette (Fig. 1). They are deep-green in colour, and somewhat coriaceous in texture. On the upper surface the hairs are confined to the mid-rib, while the ventral surface is lighter coloured, and is wholly covered with red-brown hairs.

The petiole is comparatively short and also hairy. The flowers are characterised by their green colour, hence the specific name. They arise singly in the axils of the apical rosettes of leaves on a short pedicel, which does not bear prophylls. The calyx is pale-green in colour, hemispherical in shape, and five-partite ; the lobes are imbricate, orbicular, coriaceous, membranous at the margins, which are also finely ciliated. The corolla (Fig. 2*a*, *c*) is from 2–2½ in. in diameter, rotate, five-partite ; the lobes less rounded at the apex, and deeper green in colour than the sepals, finely veined, smooth, and coriaceous, pale and membranous at the margins, but not ciliated. The throat of the corolla is short, bluish-black in colour,

* Ann. Sc. Nat., sér. 6, tom. iii, p. 139. † Bot. Mag. 1878.

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and thickly covered with whitish hairs on the dorsal surface. Where the lobes of the corolla unite, occur small, ligulate projections, the so-called staminodes. These are five in number, sub-acuminate, and slightly paler green in colour than the petals (Fig. 2). The five stamens are opposite the petals; at first closely adpressed to the style (Fig. 2*a*, *b*), later they bend outwards, and place themselves against the corolla tube (Fig. 2*c*, *d*). The filaments are broad, and united at the base around the ovary; the anthers are sub-quadrate in shape and extrorse. The connective is obtuse, truncated; the pollen sacs are situated at the apex of the anther, and a white, mealy mass, consisting of cellular fibres, at the base. The ovary is flask-shaped, with a long, slender style and discoid stigma. It is unilocular, with numerous ovules borne on a central placenta.

SHOOT.—At the close of the flowering season, *Deherainia smaragdina* begins to put forth numbers of new shoots. These shoots, like the flower buds, arise in the axils of the apical leaves of the rosette. The various stages are shown in the figures (Fig. 3, I–V). The older leaves have been cut off, and their positions are indicated by the leaf scars. These new shoots are very soft, covered with a profusion of silvery-grey hairs, and a number of reddish scale leaves at intervals. In a later stage the leaf-buds have unfolded, and formed the same rosette that characterises the old shoot. The old stem is woody in character, covered with reddish-brown hairs, as indicated, and possessing but few scale leaves. As the young stem, therefore, begins to take on a woody character, its hairs become darker in colour, and the scale-leaves gradually wither away. This can be easily seen in (Fig. 3, V), where the scale-leaves of the older shoot are relatively small and insignificant to those on a younger stem.

The internal anatomy of the shoot is interesting. A transverse section (Fig. 4) of an old stem shows a large development of sclerenchyma outside the bundles. The cells of the pith are irregular in size, and are filled with starch. They have thick walls and are pitted. The intercellular spaces are small. The xylem is transversed by numerous medullary rays which are broad, and consist of thin cells elongated in the radial direction. A well-marked cambium occurs between the xylem and phloem. Outside the phloem are patches of sclerenchyma element rays with very small lumen. At the point where the medullary emerge the sclerenchymatic cells are larger, and the circular laminations are crossed by pits (Fig. 5*b*). The cortex, consisting of thin, regular cells filled with starch, is bounded by the epidermis. The cuticle is remarkably thick and corrugated on its surface (Fig. 5*a*); this is more clearly shown in a longitudinal section (Figs. 6, 7). From the epidermis unbranched hairs are given off.

In an old stem these hairs are very markedly thickened, and often swollen at the base (Fig. 6). In a young stem these hairs are replaced by numerous, stalked glands, the heads of which contain cells very similar to the glands which are found on the petals and leaves—though these latter are stalkless. Later on, in the development of the shoot, when the cuticle becomes thick and corrugated, the glands lose their heads, and become thickened to form an ordinary septate hair (Fig. 7).

A section of the young shoot agrees in appearance—except for the absence of the marked sclerenchyma—in all respects with a section of an older shoot.

LEAVES.—The structure of the leaves of the various representative genera of Theophrastaceae—*Clavija, Jacquinia, Theophrastea*—has been described already by Votch.* More recently he describes † also the leaf of *Deherainia smaragdina*, the plant under consideration. His examination gave the following results :—

" The epidermal cells are wavy in outline, and the cuticle is striated. Hypoderm is absent. The stomata are elliptical and do not project beyond the surface. Glands are present, with sixteen cells in the head. One-cell-rowed hairs to the length of ten cells are plentiful on the under side. The palisade parenchyma are only one-rowed, and consist of short cells. The sub-epidermal sclerenchyma are present only in single isolated groups on the upper side, but form large bundles on the under side. Crystals are present in the lower epidermis. The median nerve is simple, surrounded by sclerenchyma, which does not pass through it, and the phloem surrounds the xylem on three sides."

My examination of the leaf of *Deherainia smaragdina* confirms these observations generally (Figs. 8 and 9). I found, however, that very often the stomata do project considerably beyond the epidermis (Fig. 8*a*, 9*a*). The glands are stalkless, and are found on both sides of the leaf. The hairs, which are plentiful on the under side, are confined to the portion of the mid-rib on the upper.

A transverse section of the petiole, like that of the lamina, shows a large amount of sclerenchyma surrounding the median vascular system, which gradually splits up into three separate strands as the base of the petiole is reached.

ROOTS.—The root-structure of the Theophrastaceae has not been investigated as has that of the stem and leaf,‡ but that these organs might present points of interest equal to those already described, is shown by the structure of the root of *Deherainia smaragdina*.

A transverse section (Fig. 10) of a moderately old root shows

* Votch, Dissert. Erlangen, 1903. † Engler, xxxiii (1904), Bot. Jahrb.
‡ Votch, loc. cit.

xylem in the centre arranged in a somewhat spiral fashion from the centre. The cambium is succeeded by V-shaped patches of phloem, and a many-layered pericycle bounded by the endodermis, completes the central stele. The cortex is remarkable for the size, irregular arrangement, and localised division of its cells. The piliferous layer is formed of large cells, which divide in all directions.

The root hairs are remarkable for the thickness of their walls, especially at their base. If a section be cut somewhat obliquely across the base of one of these hairs, the thickness of the walls is at once remarked (Fig. 11*a*). In the young root, the cortical cells are more regular than in the old (Fig. 11).

FLOWER.—The external appearance of the flower-parts of *Deherainia smaragdina* has already been indicated, but one or two additional points may be noted. Typically 5-partite, 6-partite flowers are not uncommon, and, though themselves solitary on their stalks, they are usually developed in pairs in the centre of the rosette, one flower much in advance of the other. The contrast in colour shade between the sepals and petals is well seen in the bud. Not only is the throat of the corolla lined with hairs which slope downwards, but it is thickly dotted with glands visible to the naked eye, as black spots (Fig. 2*a*, *d*). These glands are also distributed, though not to such an extent on the upper portion of the petals. Hooker * has described these glands as "impressed dots on the upper surface." Otherwise they are unmentioned.

The internal structure of the flower has not been hitherto described, but offers many points of interest :—

The sepals, though simple in structure, show a well-marked epidermis on both sides, exhibiting a corrugated, cuticular layer on the outer wall. The cells composing the mesophyll are large and homogeneous ; the vascular bundles are numerous, and show distinct xylem and phloem. Glands are present, are on the interior surface, but not in any great number ; these sepaline glands, in contradistinction to those at the base of the petals, are all sessile and sunk to the level of the epidermis (Fig. 12*a*).

The petals on the other hand, in cross-section, show the glands more thickly distributed than on the sepals. They occur in all stages, and their development can easily be traced. They originate from an epidermal cell, which divides transversely ; the upper cell thus formed becomes the head, and the lower, which takes no further part in the development, remains unchanged. By a series of divisions the upper cell ultimately contains about sixteen cells situated in a radiate manner like the spokes of a wheel.

* Bot. Mag. 1878.

These glands are sunk in the corolla lobes; their stalks consist of but one cell. In the throat of the corolla, however, at the base of the petals, these glands become more numerous; the basal cell divides to form a stalk of from two to three cells, and the head of the gland is raised some distance above the epidermis (Fig. 13*a*). Interspersed with the glands are unicellular hairs at intervals (Fig. 13*b*).

The microscopical character of the stamen is perhaps the most interesting in the whole of the flower. The white mass to be seen on the upper side of the anther is shown under the microscope to be composed of particles of torn fibre, like torn, woody cells. The presence of this fibrous mass had already been remarked by Decaisne * in his description of the plant.

The pollen sacs are on the under side. The cells of the anther are undifferentiated, except in the region round the pollen sacs themselves, where they are slightly thickened. Between the sacs is an open space, comparatively large, which is filled with acicular crystals in crystal dust (Fig. 14*b*). What the purpose of these crystals are, it is difficult to determine. That they bear some relation to pollination and subsequent fertilisation is doubted, from their proximity to the pollen sacs. The crystals dissolved easily in HCl. The pollen grains are minute and round, and covered with a thick, brown exine, which is minutely fringed. The cuticle of the epidermal cells of the connective is also fringed in the same manner—in appearance like the minute crystal grains on the sporangium of *Mucor mucedo*. The question of the purpose of the crystals in the anther, those on the pollen grain and on the cuticle of the connective, and the presence of the fragmentary fibrous cells on the upper side of the anther, form a part of the larger problem of the fertilisation of the flower.

The ovary in section (Figs. 15 and 16) shows a central placenta on which are situated the anatropous ovules.

The seed and fruit are unknown in Europe, and wherever it has been naturalised. The plant is easily propagated by cuttings, roots being formed at the node without much callus formation.

It has already been stated that in the young stage of the flower, the stamens are closely adpressed to the stigma, but at a later stage they fly apart, and stand with their filaments and anthers pressed back against the petals. The full significance of this fact has not yet been grasped, for nothing is known yet as to the fertilisation of *Deherainia smaragdina*. That the flower is insect-pollinated is evident by its fœtid odour, by the presence of glands on the petals and the hairs lining the throat of the corolla. Various attempts were made to artificially fertilise the flower. Experiments were made by transferring the pollen grains

* Decaisne, in Ann. Sc. Nat., sér. 6, tom. iii.

from one flower in the young stage to the stigma of a flower in a correspondingly young stage; from one flower in a young stage to the stigma of another flower in an old stage, and otherwise. These experiments were, however, put an end to by the close of the flowering season. That the pollen is not sterile is proved by the fact that it germinated slightly in a weak solution of sugar (2 per cent.), also that a ripe seed was obtained, according to Mr. L. Stewart, Foreman of the Glass Department, Royal Botanic Garden, Edinburgh, when pollen was transferred from a *Deherainia* plant to a *Theophrasta*. The microscopical character of the stamen is unique in many respects, and offers suggestions for experiments in artificial fertilisation, for which it is hoped there will again be opportunity. So far the pollen of *Deherainia smaragdina* has shown itself for the fertilisation of its own species, practically sterile.

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EXPLANATION OF PLATE LIX.

Illustrating Miss Chandler's paper on "Deherainia smaragdina, Dcne."

FIG. 1. Shoot of *Deherainia smaragdina.* ⅛ nat. size. Showing rosette of leaves and flowers.

FIG. 2. Flowers ½ nat. size.
a. and *b.* Surface and side views of young stage.
c. and *d.* Surface and side views of older stage.

FIG. 3. Short various stages in development.
I and II. *a.* Rosette of young leaves.
b. Bud of new shoot.
c. Scar of old leaf.
III and IV. *a.* Bud of new shoot not yet expanded.
b. Scale-leaf.
c. Scar of old leaf.
d. Old leaf.
V. Later stage of development. The bud has expanded and we get the rosette of leaves similar to the old shoot.
VI. Photograph of same specimen. ⅛ nat. size.

FIG. 4. Stem in transverse section. (×20.)

FIG. 5. Stem in transverse section. (×80.)
a. Cross-laminated scelerenchyma where medullary rays emerge
b. Thick corrugated cuticle.

FIG. 6. Stem showing thickened hairs on longitudinal section. (×100.)
a. Thickened hairs without swollen base.
b. The second cell above the surface of the epidermal cells beginning to divide.
c. Swollen cell above basal cell of thickened hair.
d. Cuticle beginning to thicken.
e. Thick and corrugated cuticle.

FIG. 7. Stem in longitudinal section. Young shoot arising in axil of old. (×30.)
a. Unthickened hairs, formerly glands.
b. Thickened hairs in axil of old shoot.
c. Thickened cuticle.

FIG. 8. Leaf in transverse section. (×60.)
a. Projecting stomata.

FIG. 9. Mid-rib of leaf in transverse section. (×20.)
a. Projecting stomata.
b. Hairs.

FIG. 10. Root in transverse section. (×25.)
a. Cortex.
b. Xylem.
c. Phloem.

FIG. 11. Young root in transverse section. (×20.)
a. Septate thickened hair.
b. Cortical cells.
c. Stele.

FIG. 12. Petal and sepal in bud in transverse section. (×25.)
a. Stalkless glands on corolla lobe.
b. On sepal.

FIG. 13. Petal at base of corolla in transverse section. (×20.)
a. Stalked glands.
b. Septate hairs.

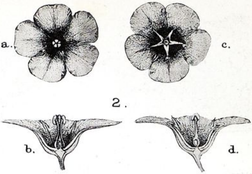
FIG. 14. Stamen in transverse section. (×90.)
a. Pollen-sacs filled with pollen grains.
b. Crystals.

FIG. 15. Ovary in longitudinal section. (×12.)
a. Central placenta bearing anatropous ovules.

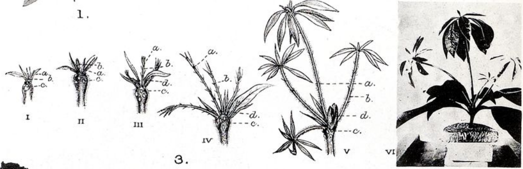
FIG. 16. Bud showing ovary in cross-section. (×10.)
a. Stamen.
b. Anatropous ovules.
c. Transverse section of ligulate staminodes.



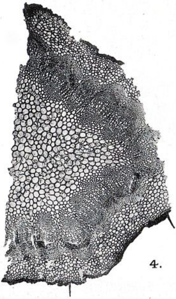
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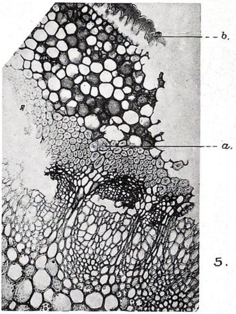
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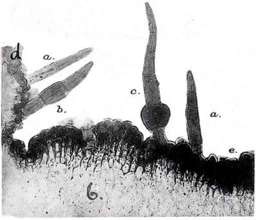
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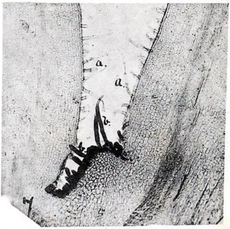


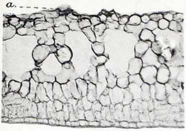
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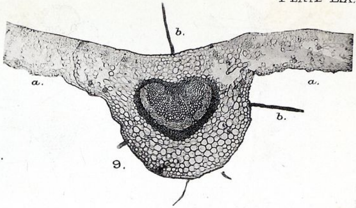
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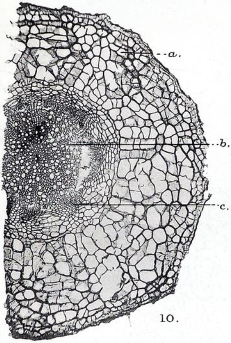




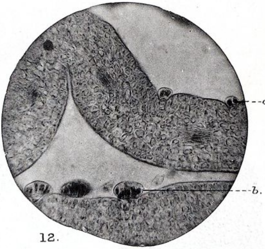
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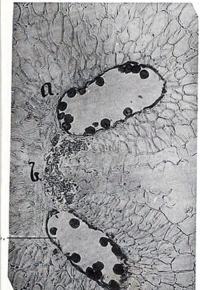
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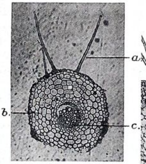
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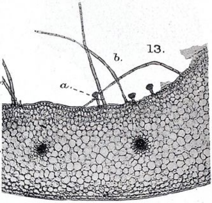
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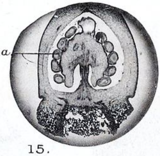
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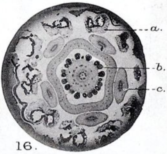
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